PCS Applications

Outputs

- Self-interference models for all PCS technologies.
- Technical contributions to industry-supported efforts for predicting, identifying, and mitigating interference related problems.
- Adapted model for use in evaluating adjacent channel systems.

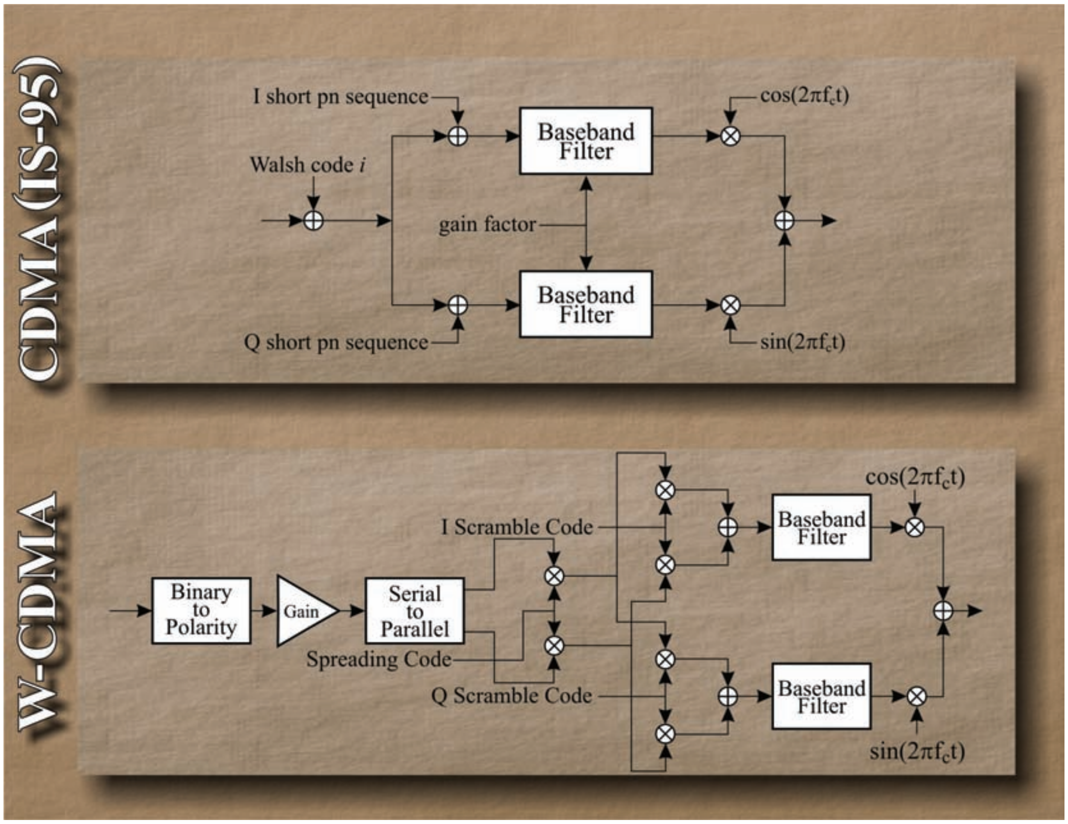
Recent natural disasters have demonstrated how important Personal Communications Services (PCS) have become in establishing emergency communications. These disasters damaged the terrestrial telecommunication system, forcing users to migrate to cellular resources. Emergency responders found themselves unable to establish inter-agency communication links, especially with responders from outside of the affected area and, as a last (or only) resort, relied on cellular systems to fulfill their missions. This sudden influx of traffic by private, commercial, civil, and Federal users resulted in wireless system overloads, a decrease in signal quality, and further disruption of service in the affected area. Beyond the physical damage caused by the events, additional factors contributed to diminished channel capacity of the wireless network, such as co- and adjacent-channel interference and the operation of multiple, independent, non-interoperable systems servicing the same geographical area, often using the same frequency bands and infrastructure (base station sites and towers).

When the infrastructure is damaged or destroyed, one solution to re-establishing communications is to deploy temporary equipment to supplement the surviving system. To make efficient use of limited resources, responders need to know what equipment needs to be deployed in which locations. Knowing the interference issues, dynamics, and load patterns of the original system is key to effective, post-disaster support by national security/emergency preparedness (NS/EP) planners and network operators in an overloaded environment.

In normal, non-disaster situations, increasing demand for wireless voice and data communications requires that the limited spectrum resources allotted to PCS be used as efficiently as possible. Code division multiple access (CDMA) is a major wireless technology used in second generation cellular systems and is becoming even more prominent in third generation systems. Code division schemes make efficient use of allotted spectrum and are relatively unaffected by noise. The capacity of technologies using CDMA is limited primarily by co-channel interference. Most automatic power control schemes in PCS systems increase power levels when the level of interference is unacceptable. This increases the interference level for all users of a common frequency band and can cause an exponential effect where all users of the spectrum are at maximum power levels and experiencing a diminished Quality of Service (QoS). With the increasing dependence on code division technology, a clear understanding of the effects of interference is essential to increase the efficiency of spectrum use.

ITS contributed to the understanding of inter-PCS interference by participating in the Telecommunications Industry Association (TIA) committee TR46.2 (Mobile & Personal Communications 1800-Network Interfaces). As a member of TR46.2, ITS contributed to the development of the Technical Service Bulletin “Licensed Band PCS Interference” (TSB-84A). This bulletin was a first step in characterizing the interfering environment caused by large numbers of active users and competing technologies. Since the completion of TR46.2’s work, coverage of PCS interference concerns has been transferred to the Alliance for Telecommunications Industry Solutions (ATIS) sub-committee WTSC/G3GRA (Wireless Technologies and Systems Committee/Radio Aspects of GSM/3G and Beyond). Work on the successor to TSB-84A is currently underway and ITS continues to be involved in interference issues with this new group.

Work in detecting, identifying, and mitigating co-channel interference requires tools to characterize the interference experienced by PCS air-interface signals. A PCS interference model is a tool that can be used to predict levels and identify sources of interference. Several standard propagation models are accepted by industry members (i.e. Okumura and COST-231/Walfish/Ikegami) but no interference model has been developed or accepted. ITS is developing a PCS interference model capable of implementing any PCS technology, starting with the ANSI/TIA/EIA-95B standard, and progressing to



Downlink diagrams for IS-95 CDMA and W-CDMA as implemented in the PCS co-channel interference model.

technologies proposed for third generation (3G) systems. The model covers system-specific interference modeling to determine co-channel interference from both immediate and adjacent cells. The model produces a representation of an instantaneous air interface signal. The signal can contain outputs of multiple base stations with variable numbers of channels for each base station and can assign relative power levels for each individual channel. Both forward and reverse link processes are included in the model. In addition to the 95B standard, the next-generation W-CDMA (Wideband CDMA) is currently being implemented. The figure shows the block diagrams of the forward data paths for both technologies.

The input for the model is a sequence of binary values. This sequence can be random, but has no requirement to be random. The model calculates each channel's signal contribution separately from all other channel's signals and then adds the processed signal to the other signal contributions to form a composite output signal. The power level for a single channel is an arbitrary gain factor of the baseband filter which is set separately for each channel.

The output of the model consists of a vector of numerical values representing a sampled QPSK or OQPSK signal. There is no error correction added to the input sequence, only spreading codes and modulation processes are used. This model does not check for recovery information contained in the input. Its only purpose is to determine how well the system can transmit the bits of the input binary sequence.

The output of the model is a sampled modulated signal which is the composite of the signals transmitted from all sources identified in a specified scenario. Software- and hardware-based simulations can use the sampled signal from the model to evaluate system designs. These simulations can characterize one-on-one, one-on-many, and many-on-one interference. As a result, potential solutions to congestion can be proposed to solve existing problems or to anticipate and avoid potential problems.

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